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INTERNATIONAL SOCIETY OF CARDIOLOGY—RESEARCH COMMITTEE

MEETING AT MAKARSKA, SEPTEMBER, 1963*

The Research Committee of the International Society of Cardiology (I.S.C.) met from September 18 to 23, 1963, at Makarska, Yugoslavia. Including invited consultants, 20 countries were represented by 54 participants. The World Health Organization was represented by Dr. Z. Fejfar from the Geneva headquarters and Dr. M. Akhmetely from the European Regional Office at Copenhagen. Dr. Paul Dudley White, Honorary Chairman, and Mr. Everett Clinchy represented the International Cardiology Foundation. Dr. William H. Goldwater represented the National Heart Institute, U.S. Public Health Service.

The Committee inspected field work on the epidemiology of cardiovascular diseases in villages near Makarska (organized by Dr. Ratko Buzina of Zagreb), and the members were assigned to four working groups for the main technical discussions of the meeting. Summaries of the reports of the working groups, as approved by the Committee and the invited experts, are given below.

The Committee established permanent Sub-Committees with initial membership as follows.

Nomenclature and Criteria: Chairman C. Kossmann (U.S.A.), Z. Fejfar (liaison from W.H.O.), J. Lenègre (France), Lukhomsky (U.S.S.R.), V. Puddu (Italy).

Lipid Metabolism and the Diet: Chairman E. Nikkila (Finland), J. T. Anderson (U.S.A.), F. Fidanza (Italy), C. J. F. Boetcher (Netherlands), D. S. Galanos (Greece), R. Goldrick (Australia), C. Gopalan (India).

Epidemiology: Chairman J. Stamler (U.S.A.), D. Alexandrow (Poland), J. N. Morris (England), C. Tejada (Guatemala), M. Toor (Israel), A. G. Shaper (Uganda), H. M. Whyte (Australia).

Electrocardiography, Vectorcardiography, and Computer Applications: Chairman H. W. Blackburn (U.S.A.), P. Duchosal (Switzerland), A. Jouve (France), N. Kimura (Japan), P. Rautaharju (Finland and Nova Scotia), P. Rijlant (Belgium), H. Schaefer (West Germany).

Hypertension: Chairman A. Taquini (Argentina), C. Bartorelli (Italy), J. Brod (Czechoslovakia), T. Hansen (Denmark), S. W. Hoobler (U.S.A.), A. L. Myasnikov (U.S.S.R.), H. Smirk (New Zealand).

Clinical Physiology: Membership to be appointed.

The Committee agreed on topics to be given special attention with a view to preparation of critical reports for the World Congress of Cardiology at New Delhi, India, in 1966, highest priority being assigned to the following:—

(1) Current status of the study of cardiopulmonary function (methods and applications);
(2) Evaluation of cardiovascular and cardiopulmonary function after cardiovascular surgery;
(3) Physical activity in relation to cardiovascular function and disease.

Five other topics were also chosen for attention:

(4) Chronic and acute cardiovascular responses and adaptations to high altitude;
(5) Effects of heat and cold on cardiovascular functions;
(6) Application of computer systems to electrocardiography and other cardiovascular recordings;
(7) Precocious ischæmic heart disease;
(8) Aetiology, pathogenesis, and clinical picture of cardiomyopathies.

The next full meeting of the Research Committee was scheduled for the spring of 1965. In the meantime, part of the Committee will meet at Kyoto, Japan, on May 8, 1964, preceding the Asian-Pacific Congress of Cardiology. Also in 1964, technical working groups will meet at Helsinki, Finland, to discuss Topic 3 (physical activity), and at Rome, Italy, to discuss Topic 5 (heat and cold).

* This Conference was supported by a grant from the International Cardiology Foundation.

Epidemiology of Special Population Groups

(Working group chaired by Dr. I. A. M. Prior)

Studies on the epidemiology of cardiovascular diseases provide information on prevalence, incidence, distribution, and on customs of diagnoses and care of these diseases. Such data indicate the socio-economic burden of these diseases and are essential for the proper provision of facilities and of technical and professional personnel for medical care. More important in the long run, epidemiological researches provide clues about ætiology and possible prevention and afford means of testing hypotheses about the relation of the development of these diseases to observable, and possibly controllable, characteristics of people and their mode of life.

Recent enthusiasm about this approach to the understanding of cardiovascular diseases is merited by the results obtained so far. It is now abundantly clear that populations and population groups differ greatly in the age-specific frequency of some of these diseases, notably coronary heart disease, though corresponding differences are not so evident in the prevalence of some other conditions, particularly hypertension and hypertensive heart disease. But beyond the current phase of exploration and conjecture, more systematic and critical research should be promoted, especially by the provision of programmes of larger scale and longer duration than have characterized much previous work. The statistical need for adequate numbers and for carefully defined samples must be strongly emphasized. Before even exploratory studies are started, it is necessary to estimate the likelihood that significant results can be obtained; this demands computations about sample size based on conceivable rates of prevalence and incidence. Details of methods and objective criteria must be spelled out in advance.

Current studies on the epidemiology of cardiovascular disease in many parts of the world fall into two main categories: (a) those in relatively developed countries concerned with populations having dietary or other characteristics that make them particularly suitable for study or in whom changes in the mode of life, spontaneous or induced, may afford special research opportunities; (b) those in less developed areas concerned with population groups that differ markedly in mode of life from that in populations characterized by high incidence of ischæmic heart disease or hypertension or both.

Much research is in progress in areas that contain population groups of special interest. Reports were presented to the Committee from such work in East Africa, New Guinea, Polynesia, Greenland, Lapland, and Israel. Some of these studies are currently of limited magnitude or scope, and there is great variability in the availability of necropsy material, but data already at hand indicate the desirability of increased support and development of such studies, preferably involving the inclusion of attention to cardiovascular questions within general health surveys.

In some other areas, a number of studies in progress are providing data that afford more critical comparison among populations in regard to both prevalence and incidence of cardiovascular diseases. Besides long-term studies begun as long ago as 1947 in the United States, research programmes involving follow-up are in progress elsewhere. A notable example is an international co-operative programme, using identical criteria, protocol, and methods, devoted to follow-up studies of men, initially healthy, in Belgium, Finland, Greece, Italy, Japan, the Netherlands, and Yugoslavia. The Research Committee received information about somewhat similar programmes in progress in Norway and Sweden and planned in other countries. It was noted, too, that under sponsorship of W.H.O., a number of European countries are currently operating or planning prevalence studies with a common protocol. All of these and similar efforts are commended.

It is agreed that the geographic pathology of cardiomyopathies of obscure origin is an international problem in the tropics, but it is also of increasing concern in other areas of the world. The interest of the W.H.O. in this problem and the establishment of a research centre in Uganda are noted with satisfaction.

Greater attention should be given to methodology in studies on the epidemiology of cardiovascular diseases. Minimal common diagnostic criteria, and technical requirements for them, should be established. Particular attention should be given to questionnaires, schedule, and forms which should be devised for and tested in various languages and cultures.

The following recommendations deserve emphasis:

(1) The efforts being made by W.H.O. and other organizations to improve and standardize methods used in epidemiological studies should be supported as actively as possible.

(2) The I.S.C. and the member Societies are urged to make widely known the facilities of W.H.O. through which information and expert assistance regarding problems in cardiovascular epidemiology may be obtained.

(3) W.H.O. should be requested to prepare technical material concerning cardiovascular epidemiology which would deal with survey methods, sample selection, equipment, and preservation of data. Recommendations are needed on minimal requirements for cardiovascular studies in general, including those in communities where surveys may form part of a general health survey.

(4) Support should be given to long-term studies in those areas of the world where unique opportunities exist in terms of ethnic groups whose living conditions are in the process of change or where groups with differing patterns of ischæmic heart disease and/or hypertension exist in close geographical relation. It is strongly recommended that the Sub-Committee on Epidemiology of the Research Committee should explore the situation regarding research potential, personnel, facilities, and financial support in such areas and make recommendations to the Research Committee of the I.S.C. (not later than April 1965).

(5) Training facilities in cardiovascular epidemiology should be extended, with particular emphasis on active participation in established field studies as well as on the theory of epidemiology. Increased exchange of personnel will contribute to this end. Short (one or two months) periods of attachment to field survey teams afford excellent experience and are highly practical both for the trainees and for the teams, but provision for the relatively modest costs is needed. Information concerning existing training facilities should be disseminated through the I.S.C. and its member Societies.

Clinical Physiology

(Working group chaired by Dr. Alberto Taquini)

Clinical physiology of the heart and circulation is a broad area that requires delimitation in practice. Methods and instrumentation for the evaluation of cardiovascular and cardiopulmonary functions, as well as the effects of physical activity and of the physical environment, are assigned to the permanent Sub-Committee on Clinical Physiology. For historical and practical reasons, a separate sub-committee should be set up for hypertension.

A systematic discussion of physical activity was provided in the report of the Princeton Conference on Methodology of Epidemiology of Cardiovascular Diseases (J. Amer. Public Health Assoc., October, 1960, Supplement). The statement below is complementary to that report.

The role of exercise in preventing or modifying the course of ischæmic heart disease has been much discussed, but the evidence is still inadequate. In order to obtain more information, an exercise test, which gives an indirect measure of ærobic working capacity, should be included in epidemiological surveys. The heart rate, and also the electrocardiogram if possible, should be recorded during standard exercise. The experience of several laboratories shows that sub-maximal exercise tests, when carried out under proper medical surveillance, are not associated with undue risk and are contraindicated in only relatively few cases.

It is desirable to document the physical activity of the subjects in epidemiological investigations. In occupations representing the extremes of activity, for example clerks and lumberjacks, common-sense classification of occupations into three categories—light, moderate, and heavy physical activity—is sufficient. However, with small differences in the muscular work required by the occupations, information on the actual amount of physical activity, both on the job and in leisure time, should be provided.

Physical activity questionnaires or histories provide some information regarding current and past physical activity, but there is little information on their reliability and validity, and more detailed studies are needed. Because cultural attitudes of population groups toward exercise influence the response to a given set of questions, information on reliability and validity cannot be transferred from one cultural group to another.

Occupational studies on the relation of coronary heart disease to physical activity encounter two difficulties. The first concerns occupational mobility and withdrawals. Disease and mortality rate relationships to particular occupations are distorted by alterations in the population structure caused by changing occupation. Data on withdrawals and occupational changes should be included in all studies concerned with the possible relation of coronary heart disease to occupation and occupational activity. Information is needed on the frequency of coronary heart disease among men who change occupation.

The second difficulty with occupational studies concerns self selection. Do men who elect employment in occupations demanding muscular work have characteristics which are not produced by their activity but which do affect the development of coronary heart disease? Studies that compare "active" and "sedentary" groups within a non-homogeneous population will not easily answer these questions.

There is much need for a well-controlled study in which the incidence of coronary heart disease in a group of sedentary men whose physical activity level has been substantially raised under supervision is

compared with the incidence in a properly selected and managed control group. Evidence on cause and effect that otherwise seems almost unobtainable could be obtained in this way. Such an undertaking would be extremely difficult and expensive, and the problem of controlling other factors that might be related to the development of coronary heart disease is formidable indeed. However, because the information to be obtained is so important, it is urged that feasibility studies be made to develop a workable design for research on experimental epidemiology of physical activity and coronary heart disease.

The natural history of hypertension has been inadequately studied, and systematic investigations are particularly needed to provide comparisons among populations differing in race and mode of life, including the diet and physical activity, and living in different climates. It is highly desirable to organize a long-term study providing follow-up for 15 to 20 years of persons found to be hypertensive in population surveys in areas affording contrasts in these variables. Population samples suitable for such studies may be found in East Africa, Argentina, Belgium, Czechoslovakia, Finland, India, Japan, Mexico, United Kingdom, U.S.A., and the U.S.S.R., among other areas that have come to the attention of the Research Committee. For this purpose, a single determination of arterial blood pressure may suffice if influences of noise, emotional stimuli, and environmental temperature are reduced to a minimum and methods are standardized.

Such a prospective study would provide the best information, but a preliminary investigation could usefully be made in retrospect in such contrasting areas. It would be reasonable for this purpose to accept as a baseline casual blood pressures recorded in years past, obtaining other medical information from existing hospital records. It would be desirable to collect, in each selected area, records of patients of both sexes who, at ages 40 to 45 at some fixed date in the past, perhaps 1947–50, were known to have had a resting blood pressure of 160/100 mm. Hg or higher and who then exhibited no other serious disorder that might impair life expectation. Every effort should then be made to trace these patients and to examine them or, if dead, to ascertain the cause. This re-examination should include retinoscopy, electrocardiography, X-ray of the heart, and renal function tests.

Lipid Metabolism and the Diet

(Working group chaired by Prof. E. Nikkila and Prof. P. Roine)

Because of obvious interrelationships between lipid metabolism and the diet and evidence that singly or jointly these variables are involved in the development of coronary heart disease, it is desirable that both subjects should be considered simultaneously.

Research on these subjects is very active all over the world, but many crucial problems remain obscure. The important differences among species and evidence for slow adaptations to dietary changes point to the necessity for much more research on man with attention to long-term responses to the diet, both in prolonged controlled dietary experiments and in critical studies of populations habitually subsisting on differing diets. In regard to dietary effects on blood lipids, it is unsafe to draw inferences from dietary extremes.

The importance of the serum cholesterol level in the development of coronary heart disease is emphasized by comparisons of patients and control subjects in all parts of the world, by comparisons among populations that differ in the frequency of the disease, and by the results of follow-up (prospective) studies on population samples of middle-aged men. The latter studies show that differences in the serum cholesterol level in health are associated with large differences in the risk of coronary heart disease in future years.

Comparisons of serum triglyceride levels of control subjects with those of patients suffering from coronary heart disease suggest that the serum triglyceride concentration may be similar in significance to the serum cholesterol in this regard. However, as yet evidence on serum triglyceride is lacking from comparisons of populations and from studies on disease incidence in follow-up studies.

Since cholesterol and triglyceride levels in the serum are far from being perfectly correlated, measurement of both variables may be substantially more useful in predicting the risk of future coronary heart disease than concentration on either variable alone. In future researches, efforts should be made to obtain parallel data on both variables though there are serious difficulties in the measurement of serum triglycerides in populations because of the need for blood in the fasting state and the fact that the analysis itself is not yet fully standardized.

In controlled dietary experiments on man, the average effect on the serum cholesterol level of changes in the major classes of fatty acids in the diet appears to be reasonably predictable for groups of clinically healthy men. Further, comparisons among populations indicate that differences in the fatty acid composition of the habitual diet are associated with differences in the average serum cholesterol level, the relation

being at least qualitatively similar to the findings in controlled experiments. However, within populations that are dietetically relatively homogeneous, differences in serum cholesterol concentration among individuals are largely unexplained by the individual diets as evaluated in short-time dietary estimates. Much more research is needed to explain intrinsic serum cholesterol differences among individuals; in regard to coronary heart disease, this may be the most important problem in the whole field of lipid metabolism.

Analytical methods in the field of lipid metabolism have greatly improved in recent years and in good laboratories are now relatively reliable for cholesterol, phospholipid, and triglycerides in the blood serum. In many laboratories, lipid analyses are still of dubious validity, and improvements are needed, especially if, as is advocated by many workers, such analyses are to be applied on a greatly enlarged scale in medical practice and in epidemiological work. With certain precautions, these substances can be stored, dried on filter paper, for later analysis at central laboratories.

Currently there is an urgent need for standard lipids and reference plasma samples to be made readily available in all parts of the world. For cholesterol, this need appears to be met through the efforts of the World Health Organization and the U.S. Public Health Service, but other lipids in the blood need similar attention. Many of the commercial triglycerides offered and used for standardization are far from pure, and every batch used for such purposes should be checked for impurities, notably mono- and diglycerides. A most serious need is for reliable and specific methods for bile acids and cholesterol derivatives in biological materials. Measurements of these substances are necessary to advance understanding of cholesterol metabolism and the effects of the diet and pharmaceuticals.

During the past year the methodology of dietary surveys concerned with the epidemiology of heart disease has been the subject of intensive research. Such surveys should obtain data on the proportion of the total calories provided by the several different classes of fatty acids—saturated, mono-ene, and poly-ene—in the diets. Because the composition of the diet often differs among members of the same family, especially between the man of the family and the children, dietary data are needed on individuals.

The basic method of reference adopted for these current dietary studies concerned with the epidemiology of heart disease involves weighing all raw and prepared foods consumed by the individual subjects for 7 consecutive days, the measurements being made or supervised by a dietitian or dietetic aide familiar with the local language and customs. Estimation of the actual nutrients in the foods eaten has been made both from tables of food composition and from direct chemical analysis of composites of the food corresponding to the make-up of the week's diet, those foods being locally obtained and prepared. This method is satisfactory in principle but is laborious, and improvements in many technical details are needed. Direct chemical analysis is undertaken because tables of food composition currently available do not apply to important foods in many areas and are subject to error because of variations in composition of ostensibly the same foodstuff from region to region and even from sample to sample in the same region. Better tables of food composition, with more attention to fatty acid composition, are needed. With this, as well as with all other methods, it is essential to assure that the diet is not altered as a result of the fact that it is being measured. Account must be taken of the consumption of between-meal snacks and of alcoholic beverages.

Comparisons, with the same individual subjects, of this method of weighing with the method of careful interview and dietary recall, show good agreement for the averages for groups of subjects in relatively sophisticated populations, but serious discrepancies are common for individuals. Results of the interview-recall method may give a good general picture of the habitual diet but are of dubious value for examining the contemporary relation between individual diets and the blood of those individuals.

The method of choice for a dietary study is determined by the purpose of the study. Crude methods can indicate general trends for populations for which no other dietary data are available. Food balance calculations from estimates of food production, export and import, give some idea of the over-all dietary pattern of a country, but the basic statistics are often subject to large errors and provide no information about the distribution of the food among different segments of the population. Useful inferences about the food habits of a region or of particular population groups may be made from data on food consumption in institutions such as colleges, student dormitories, hospitals, prisons, military installations, etc., and such institutions also may offer opportunities for experimental studies. Rough estimation of the diets of such institutions can be made from records of food purchases, but these must be supplemented by random measurements of actual food servings and plate waste plus estimates of consumption of foods and beverages besides those supplied by the institutional meals. Gross errors may result if the actual diet is simply inferred from the official diet or ration prescribed.

For the free-living population, it is easier to estimate the diet of the family instead of that of the indi-

viduals, but, as noted above, may lead to serious errors in the estimation of the diets of particular component members of the family.

A dietary survey provides information about the diet at the time of the survey but not necessarily for other times of the year or for past years. Recent studies on seasonal variation in the diet in several rural populations in Europe indicate that, except for vitamins, the actual nutrient content of the diet may show little seasonal variation in spite of major changes from season to season in the food items used. This question needs further study in other populations.

So far, the most detailed studies on the diets of free-living populations in connexion with the epidemiology of heart disease have mainly concerned rural populations. There is a need for comparable studies on city dwellers, but it is much more difficult to enroll proper samples of people and secure the requisite co-operation from them in cities than in villages. Self-selected volunteers for dietary surveys seldom provide reasonable representation of the population as a whole.

In connexion with research on the epidemiology of heart disease, dietary studies must attempt to provide data about possible relationships between the diet and the development of disease. Presumably, the effects of the diet, if any, on atherogenesis or the development of hypertension are exercised over many years, so it is essential to ask whether the contemporary diet recorded in a survey truly reflects the long-time dietary history of the persons or populations concerned. Some guidance on this point may be had from older dietary surveys, food balance data, records of diets in institutions, etc., of the region. Uncritical attempts to correlate vital statistics of the past with crude estimates of the contemporary diets of populations are to be deplored.

Elucidation of dietary influences in the epidemiology of cardiovascular disease is obviously extremely difficult. Nevertheless, the importance of the problems and the indications from the work done so far warrant great research effort. Further studies on the methodology of dietary studies are essential and should result in important gains in the efficiency and validity of such work.

ELECTROCARDIOGRAPHY, VECTORCARDIOGRAPHY, AND COMPUTER APPLICATIONS

(Working group chaired by Dr. Henry Blackburn)

Electrocardiographic (ECG), vectorcardiographic (VCG), and computer analytical techniques are increasingly used both in clinical and epidemiological studies of cardiovascular disease. On the basis of a review of the status of these techniques, the following recommendations are made for more effective use of the methods in international population studies.

Conventional Electrocardiography. For population comparisons a minimum is adopted of 12 conventional leads at rest (I, II, III, aVR, aVL, aVF, V_{1-6}) as recommended by the Cardiovascular Diseases Unit of the World Health Organization (Burgess, Fejfar, and Kagan, *WHO Chronicle* 1963).

The following items of the Minnesota Code (refer to Circulation 21: 1160, 1960) have been found most reliable for ECG classification in comparisons of the prevalence of ECG abnormalities. Other items of the Code are satisfactory for group rate comparisons, but individual observer agreement is low:

(1) Q and QS Class I, 1 (large Q waves);
(2) S–T depression Class IV, 1 (XI, 1) (S–T–J depression 0·1 mv. or more in selected leads);
(3) Negative T Class V, 1 and 2 (XII, 1 and 2) (distinctly negative T wave in selected leads);
(4) Complete right and left bundle-branch block: Class VII, 1 and 2;
(5) Arrhythmias of Class VIII, 2 through 6.

The following revision of the S–T depression code in that classification is proposed to provide more detail and better separation of junctional (J) from "ischæmic" type depression. Recoding involves only reading again those tracings coded IV, $_1$ (XI, $_1$, and XIX, $_4$) under the existing published classification. It preserves the policy of coding the first (lowest numbered item) criterion met by the tracing in preference to subsequent criteria if the findings coexist. It eliminates the code for S–T segment elevation which is not a mutually exclusive item and which is unreliable.

Code for Resting Electrocardiograms (IV). IV S–T junction and segment (measured from preceding P–R interval at onset of QRS).

Code for Post-exercise Records (XI). Existing item XI, $_4$ should now read:
XI, $_4$ Change from *no* coded S–T item at rest to S–T item type IV, $_4$ post-exercise.

Existing item XI, $_4$ should be advanced to XI, $_5$ and subsequent numbers advanced one digit.

It is suggested that the same criteria be applied to records taken *during* exercise until better standards become available.

(IV) Code for Resting Electrocardiograms	Any of Leads
1. S–T–J depression of 0·1 mv. or more *and* S–T segment horizontal or downward sloping	I, II, aV_L, aV_F, V_1–V_6
2. S–T–J depression 0·05–0·09 mv. *and* S–T segment horizontal or downward sloping	I, II, aV_L, aV_F, V_1–V_6
3. No S–T–J depression as much as 0·05 mv. *but* S–T segment sloping down and reaching 0·05 mv. or more below P–R baseline	I, II, aV_L, aV_F, V_1–V_6
4. S–T–J depression 0·1 mv. or more *and* S–T segment upward sloping	I, II, aVL, aVF, V_1–V_6

Code for Serial Electrocardiograms (XIX). Existing item XIX, $_7$ should now read:
XIX, $_7$ Change from *no* coded S–T item to S–T item type IV, $_4$ rest or post-exercise.
Existing item XIX, $_7$ should be advanced to XIX, $_8$.

Vectorcardiography. The desirability is affirmed of standardizing *at this time* the VCG system *for epidemiological use* in heart disease studies, and one system should be adopted while development and testing of improved systems is proceeding. Several systems based on the concept of the lead vector have been developed in recent years. Of these, it is a fact that the Frank system (recorded supine with horizontal electrodes in the plane of the 4th intercostal space at the sternum) is the most widely used in population studies.

Encouragement is recommended to work seeking to improve corrected orthogonal VCG leads, with their verification both in models and human subjects, and to the development of quantitative VCG criteria.

Non-corrected VCG lead systems may provide added information to that obtained from corrected orthogonal VCG systems, and the systematic investigation of data from specially distorted lead systems is desirable. The place of non-corrected VCG lead systems, such as Kimura leads, in population studies awaits empiric evaluation of findings from existing systems now employed in such studies.

Exercise ECG Test. Previous recommendations by authoritative bodies have considered the potential risk to the subject as a principal reason for not performing exercise tests in population studies. Review of the experience of over 10,000 ECG exercise tests in which subjects with manifest heart disease were excluded from the effort disclosed that no serious events have been attributed to the test. Evidence from centres involved with work capacity evaluation of heart subjects indicates an extremely small risk when tests are properly monitored and supervised.

The difficulties in reading and interpretation of a positive ECG response to effort were reviewed. There is not evidence enough to recommend such tests as routine for surveys *principally* concerned with comparison of *heart disease rates.* Effort tests are, however, recommended for studies concerned with assessment of cardiovascular function or the risk of future attack or death.

For performance of the test, it is recommended that a well-defined and reproducible submaximal work load be imposed. A minimum "working" criterion for presence or absence of a positive ECG finding during or after effort is proposed: 0·1 mv. or more S–T junction depression, with horizontal or downward sloping contour, in any of leads I, II, aVL, aVF, V_1 through V_6 in either of two post-exercise tracings obtained within 4 minutes after cessation of effort. Further standardization of leads, work load, and criteria for interpretation of ECG responses should be sought. ECG recording *during* exercise is recommended as a monitoring device. Systematic studies are needed on lead arrangements and S–T–T measurement for the ECG *during* effort.

Noise Reduction. The contribution of "noise" and baseline shift to errors in ECG classification is serious in all types of ECG instrumentation. For reduction of noise, detailed recommendations are available from the Research Committee. They apply known principles, as well as newer approaches, including averaging techniques, to improve the "signal-to-noise ratio".

Magnetic Tape Recording of ECG—VCG. The Sub-Committee has considered the likelihood, in the near future, of collection, storage, and analysis of ECG data with the aid of magnetic tape recorders within medical centres and in population studies. Large investments in tape instrumentation are even now being made. At the data-collecting phase a high level of engineering competence is required. An outline of technical details and testing procedures of special concern to those anticipating use of biomedical tape-

recording systems is in preparation by a sub-committee of the Research Committee. Before the establishment of tape systems, preliminary consideration should be given to the factors outlined below. These suggestions refer principally to the data collection side of magnetic tape-computer ECG systems. Investigators have the principal responsibility here but can arrange collaboration with large centres for analytical programmes.

(1) Competent engineering aid is required to set up and operate biomedical tape systems.

(2) Control units for tape recorders must be designed in collaboration with those who will process the data.

(3) Instrumentation in this field is still in development, no apparatus is entirely satisfactory, and many have serious limitations.

(4) Specifications by suppliers, especially regarding noise level, are expressed variously and may be misinterpreted, while important characteristics may be omitted from descriptions. Satisfactory performance for the needs of the investigator, in testing after delivery, should be prerequisite to purchase.

(5) All apparatus available gives problems with noise, and methods for their solution involve sacrifices in data and may be costly.

(6) All biomedical tape recorders available have satisfactory frequency response characteristics, at different costs, for electrocardiographic work, and most allow analysis of high frequency ECG components.

(7) Time required for the machine to get up to operating speed must be considered in the light of the data-processing method used and tape costs.

(8) IRIG standard tape head configuration is a great practical advantage to collaborative collection-analysis programmes.

(9) Density of data recording at different sensitivities relates to the research needs and tape cost.

(10) Preamplifiers designed for operation with specific tape units are unavailable at this time.

(11) Input-output range of the recorder is important in regard to the type of data involved, as is behaviour of the instrument when loads are imposed which exceed its operating range.

(12) Input-output impedance, unity gain calibration, and an external calibration source are important concerns.

(13) The number of channels, the ability to expand the system, and loss of data channels for noise compensation should be considered.

(14) Magnetic tape of quality adequate for programmes of automated computer recognition should be used.